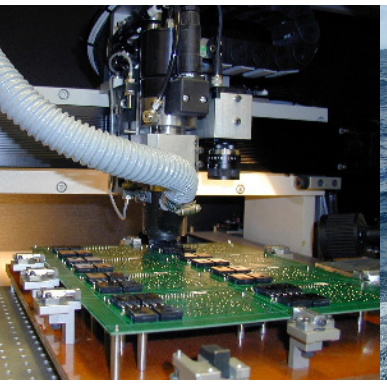
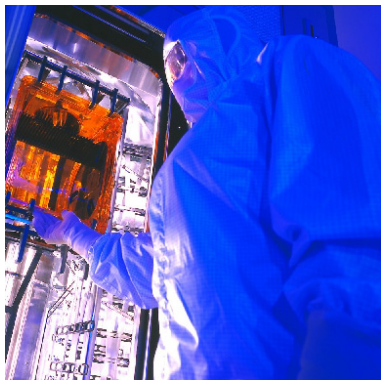
ADVANCED MOTION CONTROLS





Everything's possible.

QuickStart

BL3416E2-A04-AC120

User Manual

Plug-n-Play Servo System with Analog Drive, Brushless Motor and Cables (Continuous 16 lb-in, 4500 rpm)

BL3416E2-A04-AC120

Thank you for purchasing this QuickStart package!

QuickStart makes it easy to set up Advanced Motion Controls drives to get your system running quickly. The drive and motor have been matched with each other, the cables are custom made for this system and an interface board simplifies integration with your controller.

Remember, if you need us, we are here for you!

Our goal is to get you up and running as quickly as possible. If at any point you have a question, a team of applications engineers and our customer service staff are just a phone call away. We are available weekdays from 8am to 5pm Pacific Time at 805-389-1935. We can also be contacted via email through our website www.a-m-c.com - go to "Contact Us".

4 Steps to Success!

1	2	3	4
Getting Started	**5-Minute QuickStart**	**Integrate QuickStart into Your System**	**Going into Production**
What's included with QuickStart and what to expect	Let's spin the motor!	Get your machine working.	Transitioning from prototype to production.

This manual has been laid out in four sections to guide you through the process of setting up and integrating your QuickStart system. By following each step in succession you will first be introduced to QuickStart, then hook up the system for a simple bench test, and then integrate QuickStart into your machine and finally transition into the production stage.

1 Getting Started

1.1 What to Expect

What is 'QuickStart'? QuickStart is a system offering including: a drive, a motor, all necessary cables, and an interface board with screw terminal connections - all in one box ready for fast delivery!

What purpose does 'QuickStart' serve? QuickStart is intended to introduce OEMs to Advanced Motion Controls servo drives and provide a positive first experience.

Why is Advanced Motion Controls offering a 'QuickStart' package? We realize that many OEMs today are faced with trying to get their machinery to market using the fastest possible methods. Our solution is to provide a means by which motion control can be quickly proven.

How does 'QuickStart' benefit potential customers? QuickStart is designed to make system prototyping easier to include Advanced Motion Controls' servo drives. The attraction to OEM's is a savings of time, money and the personnel needed to move from conception to production. Upon receipt, everything will plug in and operate within 5 minutes. All systems are initially configured in velocity or voltage mode to turn the motor shaft at 30 +/- 20 rpm. This is an indication that when put together, it works out of the box. No pots to tweak or software to configure!

Are 'QuickStart' program motors available for individual resale? Quite simply, not from Advanced Motion Controls. The motors in these packages are meant to represent what is commonly available from many different manufacturers. Your local Advanced Motion Controls representative can handle requests for motor model information for additional purchases.

How is 'QuickStart' pricing important to me? Careful selection of systems incorporate popular Advanced Motion Control's drives in order to maximize exposure and minimize costs.

What other considerations should you know about 'QuickStart'? Although it will be hard to find easy-to-configure systems like these at lower prices anywhere, QuickStart isn't intended for multiple, pre-packaged system selling. Initial exposure to Advanced Motion Controls' drives is the key. Each project will be followed up by our Sales department to determine overall progress and assist in determining the next step.

1.1.1 Package Contents

❑Brushless Servo Drive	BX25A20AC
❑Brushless NEMA 34 Motor w/encoder	MBL3416E2
❑Screw Terminal Board	SIB (System Interface Board)
❑Feeback / Commutation Cable (10 foot)	CBL-F01-10
❑Motor Power Cable (10 foot)	CBL-P02-10
❑Drive Power Cable	CBL-AC-IEC
❑Drive Cable (1.5 foot)	CBL-D02
❑Documentation	Quick Connect Sheet
	User Manual
	Brochure

1.1.2 Additional Requirements

Item	Notes
Power Supply	**Requirements:** •120 VAC 60 hz Single Phase •Acceptable Operating Range 30 - 125 VAC
Controller	±10V Command Signal.

2 5-Minute QuickStart

Let's Spin the Motor!

This quick setup procedure will get the motor moving in a short amount of time *without the need for a controller*. The drive has been pre-configured in **Encoder Velocity Mode** with a slight offset. This will turn the motor at a slow steady speed on power-up to demonstrate operation. Once the system is shown to be operational, the next section - Integrate QuickStart into Your System - will guide you through the process of integrating the system into your application.

2.1 Wiring

In Section 2.4, you will find the cables and connections sheet. Use this as a reference when following the steps in this section.

2.1.1 Drive

Connect cable CBL-D02 to the P1 and P3 connectors on the drive. Connect the other end to the C2 connector on the System Interface Board (SIB).

2.1.2 Feedback

CBL-F01-10 is the feedback cable. Connect the black connectors and shield drain wire on this cable to the corresponding connectors on the motor. Connect the 15-pin D-sub to the C1 connector on the System Interface Board (SIB).

2.1.3 Motor

Connect the white connector on the motor power cable CBL-P02-10 to the corresponding connector on the motor. Connect the green connector to the P2 connector on the drive.

Red	Motor A, P2-1
White	Motor B, P2-2
Black	Motor C, P2-3

CBL-AC-IEC supplies AC to the drive. Do not apply power at this time. An AC power strip or other switch can be used to make cycling power more convenient during testing.

2.2 Grounding

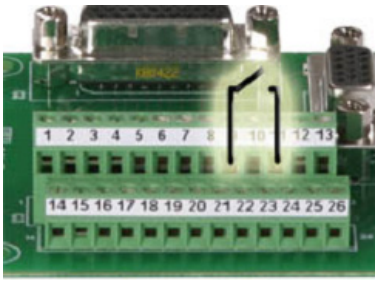
Bring all ground wires to a central point ground such as a ground bus, ground plane or a single ground bolt. Also don't forget to ground the drive chassis! Use the silver screw marked PE on the case.

2.2.1 Motor Ground

The green wire coming from the motor power cable is the motor chassis ground. If the motor case is already grounded through direct contact with the machine housing, then leave the green wire disconnected. Grounding the motor at both the green wire and at the motor case causes a ground loop that has been shown to disrupt the feedback signals. Choose one or the other.

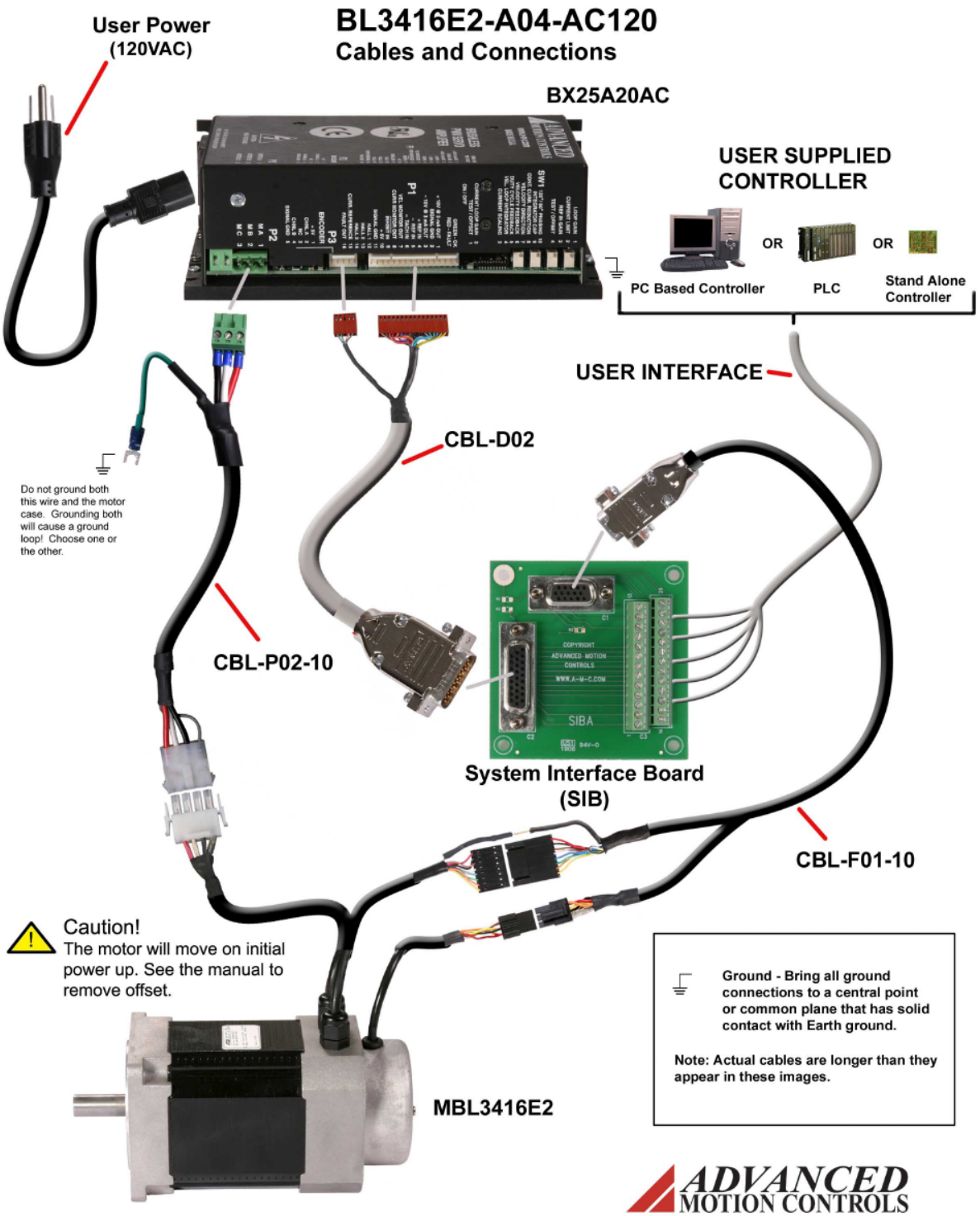
2.3 Inhibit Switch (optional for this section)

An inhibit switch (not included) can be connected between pins 9 and 11 on the Interface Board. This switch disables power to the motor until you are ready. Opening the switch Enables the drive, closing the switch Disables the drive.



To avoid the motor from jumping unexpectedly and causing damage, the motor should be secured either with clamps or bolted down using its mounting holes.

2.4 Cables and Connections



2.5 Inhibit Line Test (optional)

Follow this step only if you installed the inhibit switch described in Section 2.3. This is to verify that the optional inhibit switch is functioning and the drive is initially powered up in a disabled state.

1. Disconnect the motor power by unplugging the white connector on CBL-P02-10. Unplugging this connection allows you to power up the system without the possibility of spinning the motor.
2. Apply power to the drive. Toggle the inhibit switch and verify that you can cause the LED color to change from Red to Green. Set the switch so the LED is Red.
3. Remove power from the drive and reconnect the white connector on CBL-P02-10.

2.6 System Power-Up

1. Apply power to the drive. If an inhibit switch has been installed, enable the drive by toggling the inhibit switch so the LED turns Green.
2. The motor should turn at a smooth controlled speed.
3. If the motor turns then the system has been hooked up correctly. Remove power and continue to the next section. If not then go to Troubleshooting.
4. To stop the motor from turning, turn the Test/Offset switch (SW1-1) to the OFF position. Then use the offset pot (Pot 4) to set the speed to zero. The motor may continue to creep very slowly when in velocity mode. True zero speed can be achieved once a controller is used to close the loop around the servo drive.

2.6.1 Troubleshooting

LED not lit.	Verify that power has been applied to the drive.
Motor doesn't have holding torque	Verify that the LED is Green.
LED doesn't turn Green.	Verify all cables are connected. If an Inhibit Switch has been installed, toggle the Inhibit switch.
Motor doesn't turn but has holding torque	Turn Pot 4 (Test/Offset) in either direction. This will change the amount of offset in the drive.
Contact Factory - If you can't get the motor turning within a few minutes, please call and ask for technical support! 805-389-1935. We want to get you up and running quickly!	

3 Integrate QuickStart into Your System

The following instructions are a continuation of the previous chapter. This section explains controller wiring, drive configuration, drive mounting, motor mounting, SIB mounting and load coupling.

3.1 Wiring

3.1.1 Signal Ground

Almost all signals between the drive and the controller are referenced to signal ground. Without this reference, the drive and the controller would not be able to transmit signals to each other. To ensure that the signals between the drive and the controller are referenced to the same potential, the signal grounds on the controller and the drive must be connected together. This is especially important for:

- Single ended command signals
- Inhibit line
- Other inputs and outputs.

You will need to identify the signal ground on your controller and connect it to the signal ground on the drive. For your convenience, the Signal Ground is accessible at three locations on the SIB. However, **to avoid ground loops** there should only be one connection between the drive signal ground and the controller signal ground. Don't add a connection if there is already continuity between the two grounds.

Available Signal Ground Locations on the SIB

Controller	SIB
Signal Ground	C3-2 (SGND)
	C3-11 (SGND)
	C3-19 (SGND)

3.1.2 Command Signal

Command signal and mode selection are dictated by the capabilities of your controller and the desired operation of your system. Analog ±10V command signals are suited for torque and velocity modes.

±10V Command Signal (Single Ended)

Signal	SIB	Available Drive Modes
SGND	C3-2 (SGND)	Torque Mode, Velocity Mode
Command	C3-4 (Ref+)	

±10V Command Signal (Differential)

Signal	SIB	Available Drive Modes
Command +	C3-4 (Ref+)	Torque Mode, Velocity Mode
Command -	C3-5 (Ref-)	

More Information on Mode Selection Drive modes can be separated into three basic categories: Torque, Velocity and Position. The name of the mode describes what servo loops are being closed in the drive. They don't describe the end-result of the operation. For example, a drive in Torque mode can still be in a positioning application if the external controller closes the position loop. In fact, most high performance positioning systems use a drive in torque mode with the controller closing the velocity and position loops.

The correct mode is determined by the requirements of the controller. Some controllers require that the drive be in torque mode. Other controllers require that the drive be in velocity mode. Check the documentation on your controller or contact the manufacturer of your controller to determine the correct mode for your drive.

Once the command signal and mode have been selected, connect the controller to the signals as indicated in the above tables. The proper gains and command settings must also be configured. This will be explained later in the configuration section.

3.1.3 Drive Inhibit (Recommended)

The inhibit line is used to turn off power to the motor while the drive is still powered on. Sometimes this is necessary if power to the motor needs to be removed quickly or if the user needs to manually move the load in a freewheeling condition. If your controller has an inhibit function then we highly recommend that you use it.

Inhibit Connection

Controller	SIB
Inhibit	C3-9 Inhibit

Note that the inhibit input is configured to disable the drive when pulled low (active low). The control logic can be inverted by setting SW2-3 to the OFF position.

3.1.4 Feedback

The feedback on the motor is an incremental encoder with two Channels (A and B) and an Index (I). The signals are differential but are compatible with single ended circuitry (simply leave the complimentary signals open A-, B- and I-). The resolution is 10000 counts per revolution (quadrature).

Power Requirements - Encoder power is supplied by the drive. 5VDC @ 125mA.

The screw terminals on the System Interface Board (SIB) provide easy access to the encoder signals.

Encoder Connection

Signal	SIB
SGND	C3-19
5VDC	C3-20
Channel A+	C3-21
Channel A-	C3-22
Channel B+	C3-23
Channel B-	C3-24
Channel I+	C3-25
Channel I-	C3-26

3.1.5 Drive Mounting

Mounting Dimensions are found in the drive datasheet in the Appendix.

The drive can be mounted flat against the base plate or along the spine.

Mounting the drive flat on the base plate against a large thermally conductive surface for cooling will provide the most natural heat dissipation for the drive. A metal back plane in a cabinet on the machine often makes a good surface.

Drives mounted on the spine can be mounted next to each other. Maintain a minimum separation of 1 inch between drives to provide adequate convection cooling.

Note

Additional cooling may be necessary to dissipate the heat generated by the drive depending on ambient temperatures, duty cycle and natural ventilation.

3.1.6 Motor Mounting

Mounting Dimensions are found in the motor datasheet in the Appendix.

The mounting surface must be stiff enough so it does not deflect when radial loads are applied to the motor shaft. The mounting surface should also have good thermal conductivity, especially if peak performance is demanded of the motor.

3.1.7 SIB Mounting

Mounting Dimensions can be found in the SIB datasheet in the Appendix.

The SIB can be mounted using the mounting holes or a DIN tray such as from Phoenix Contact. If using the mounting holes, standoffs must be used to keep the bottom of the SIB from shorting with the mounting surface.

3.1.8 Cable Routing

Cable Datasheets can be found in the Appendix.

QuickStart cables come with excellent shielding and make proper grounding easy. This makes proper cable routing less critical, however proper routing practices should still be followed.

Route cables to minimize length and minimize exposure to noise sources. The motor power wires are a major source of noise and the motor feedback wires are susceptible to receiving noise. This is why it is never a good practice to route the motor power wires close to the motor feedback wires even if they are shielded. Although both of these cables originate at the amplifier and terminate at the motor, try to find separate paths that maintain distance between the two. A rule of thumb for the minimum distance between these wires is 1cm for every 1m of cable length.

3.1.9 Grounding

Bring all ground wires to a central point ground such as a ground bus, ground plane or a single ground bolt. Also don't forget to ground the drive chassis! Use the silver screw marked PE on the case.

Motor Ground The green wire coming from the motor power cable is the motor chassis ground. If the motor case is already grounded through direct contact with the machine housing, then leave the green wire disconnected. Grounding the motor at both the green wire and at the motor case causes a ground loop that has been shown to disrupt the feedback signals. Choose one or the other.

3.1.10 Load Coupling

A non-rigid coupling must be used between the motor shaft and the load to minimize mechanical stress due to radial loads, axial loads or misalignment. If you feel that the radial load on the motor is excessive, you may want to consider connecting the motor to an idler shaft that is supported by pillow block bearings (or similar). Then the load can be coupled to the idler shaft without risking damage to the motor bearings.

3.2 Configuration

BX25A20AC Capabilities

Mode Category	Mode Name
Torque	Current
Velocity Estimation	Duty Cycle*
Velocity	Encoder Velocity
	Hall Velocity**

*Duty Cycle Mode does not use direct feedback to close the velocity loop; therefore, it can't be considered a true velocity mode. Duty Cycle Mode produces velocity that is roughly proportional to the input command but is not as precise as using a Tachometer or Encoder.

**Hall Velocity Mode is not recommended with this system since Encoder Velocity Mode is available with superior velocity control.

The correct mode is determined by the requirements of the controller. Some controllers require that the drive be in torque mode. Other controllers require that the drive be in velocity mode. Check the documentation on your controller or contact the manufacturer of your controller to determine the correct mode for your drive.

Advanced Motion Controls Analog Servo Drives are configured using Switches and Potentiometers. There is no software to download or configure.

The basic setup of these servo drives is straight-forward and user-friendly. These instructions will walk you through the steps necessary to configure your drive to your system:

- Configure the drive mode.
  - Torque Mode Configuration
  - Velocity Mode Configuration
    - ->Encoder Velocity
    - ->Hall Velocity
    - ->Duty Cycle

3.2.1 Torque Mode Configuration

The terms 'Torque Mode' and 'Current Mode' are synonymous. They can be interchanged and you may see either of these terms throughout this document and other motion control documents. The Switches and Potentiometers set the mode on the drive. Use the Mode Selection Table for the correct configuration.

Mode Selection Table - Torque Mode*

Switch Bank 1	**SW1-1**	OFF
	SW1-2	ON
	SW1-3	ON
	SW1-4	ON
	SW1-5	OFF
	SW1-6	OFF
	SW1-7	ON
	SW1-8	ON
	SW1-9	ON
	SW1-10	ON
Switch Bank 2	**SW2-1**	OFF
	SW2-2	OFF
	SW2-3	ON
	SW2-4	ON
	SW2-5	ON
	SW2-6	ON
Pots	**Pot 1** - Loop Gain	Full CCW
	Pot 2 - Current Limit	Full CW
	Pot 3 - Reference Gain	Full CW
	Pot 4 - Offset	Mid (7 turns)

*Current Limit with these settings - 12.5A continuous, 25A peak

Potentiometer Instructions CW is the clockwise direction, CCW is the counterclockwise direction. Full CW or Full CCW means the pot has been turned to the end of its travel where it begins to click on every turn. These potentiometers have a 14 turn range before they start to click. The number of potentiometer turns on the Mode Selection Table is referenced from the full counterclockwise position. To maintain consistency in the number of turns the initial starting point is defined as follows:

1. Turn the pot CCW until the pot begins to click on every turn.
2. Continue to slowly turn the pot CCW until the next click is heard, then stop.
3. Now turn the pot in the CW direction the number of turns indicated in the Mode Selection Table.

Gain Setting The gain of the drive (amps out)/(volts in) can be adjusted using the Reference Gain Potentiometer, Pot 3. Turning the pot to the full clockwise position results in a gain of roughly 2.5A/V. Turning the pot counter clockwise reduces the gain down to a minimum of zero.

3.2.2 Velocity Mode Configuration

Velocity mode outputs a velocity that is proportional to a given input command. The gain can be expressed as (output velocity)/(input command). Common units are (rpm)/(V) and (counts per second)/(V).

The three velocity modes available in this system offer varying degrees of performance. Starting with the highest performance, they are listed below.

Encoder Velocity Uses the encoder as the velocity feedback. This mode is very accurate over the widest range of speeds.

Hall Velocity This mode uses the Hall sensors for velocity feedback. This mode is not accurate at slow velocities, but as the speed increases beyond 1000 rpm this mode becomes more usable. This mode is popular in systems where the cost of an encoder is prohibitive and the operating velocity is above 1000 rpm.

Duty Cycle This mode does not use any feedback to determine velocity. Velocity is estimated by the duty cycle of the PWM. Duty Cycle Mode is the least accurate of these velocity modes.

The Switches and Potentiometers set the mode on the drive. Use the Mode Selection Table for the correct configuration.

*Mode Selection Table - Velocity Mode**

		Encoder Velocity	Hall Velocity	Duty Cycle
Switch Bank 1	**SW1-1**	OFF	OFF	OFF
	SW1-2	ON	ON	ON
	SW1-3	ON	ON	ON
	SW1-4	OFF	OFF	OFF
	SW1-5	OFF	OFF	ON
	SW1-6	ON	ON	OFF
	SW1-7	ON	ON	ON
	SW1-8	ON	ON	ON
	SW1-9	OFF	ON	OFF
	SW1-10	ON	ON	ON
Switch Bank 2	**SW2-1**	ON	OFF	OFF
	SW2-2	OFF	ON	OFF
	SW2-3	ON	ON	ON
	SW2-4	ON	ON	ON
	SW2-5	ON	ON	ON
	SW2-6	ON	ON	ON
Pots	**Pot 1** - Loop Gain	8 turns	10 turns	9.5 turns
	Pot 2 - Current Limit	Full CW	Full CW	Full CW
	Pot 3 - Reference Gain	Full CW	Full CW	Full CW
	Pot 4 - Offset	Mid (7 turns)	Mid (7 turns)	Mid (7 turns)

*Current limit with these settings - 12.5A continuous, 25A peak

Potentiometer Instructions CW is the clockwise direction, CCW is the counterclockwise direction. Full CW or Full CCW means the pot has been turned to the end of its travel where it begins to click on every turn. These potentiometers have a 14 turn range before they start to click.

The number of potentiometer turns on the Mode Selection Table is referenced from the full counterclockwise position. To maintain consistency in the number of turns the initial starting point is defined as follows:

1. Turn the pot CCW until the pot begins to click on every turn.
2. Continue to slowly turn the pot CCW until the next click is heard, then stop.
3. Now turn the pot in the CW direction the number of turns indicated in the Mode Selection Table.

Loop Gain - Potentiometer 1

In Velocity Mode the loop gain increases the responsiveness of the system. The loop gain settings in the mode selection table are a good starting point. However, once the drive is in the system, the loop gain will need to be adjusted to match the system dynamics.

To adjust the Loop Gain:

- Turn the Loop Gain pot to the full counterclockwise position.
- Enable the drive
- Turn the Loop Gain pot clockwise.
- When the system begins to make a loud buzzing noise, turn the pot in the counterclockwise direction until the buzzing stops.
- Turn the pot one more turn in the counter clockwise position.

Reference Gain - Potentiometer 3

The gain of the drive (velocity out)/(volts in) can be adjusted using the Reference Gain Potentiometer, Pot 3. Turning the pot clockwise increases the gain, while turning the pot counter clockwise decreases the gain.

4 Going into Production

4.1 Prototype to Production

Once you have completed your proof of concept you will be ready to design for production. If you decide that the QuickStart drive and motor are perfect for you then you're in luck. Both are popular off-the-shelf items that are readily available. Drives can be ordered directly from us and we can put you in touch with the appropriate motor supplier.

If your servo system requires a drive that better fits your application such as:

- Additional features
- Different power range
- Smaller size
- Different form factor such as 'plug in' style drives
- Network connectivity

Then our applications engineers can help optimize your system by selecting the best drive for your needs.

You will also be in contact with a local representative to help you with the selection of motors and other system components such as cables, gear boxes, slides, bearings and more.

Feedback

Your feedback is important to us. Your comments can make QuickStart better and help us improve our processes, technical support, customer support and product offering. Please go here to provide us your feedback.

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Appendix

A. System Specifications

B. Drive Datasheet

C. Motor Datasheet

D. Cable Datasheets

E. System Interface Board

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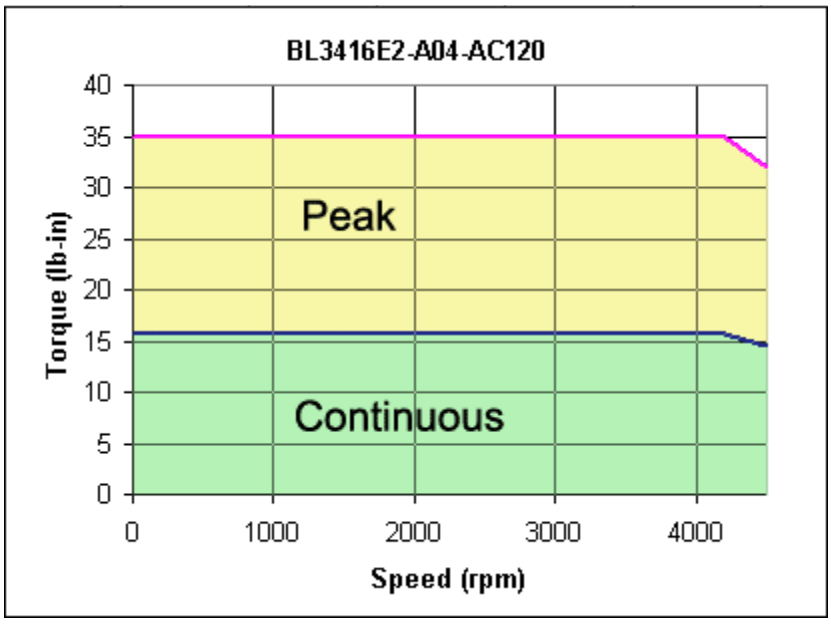
A.1 System Specifications

Torque - peak	35 lb-in, 3.975 Nm
Torque - continuous	15.63 lb-in, 1.77 Nm
Velocity Maximum	4500 rpm
Supply Voltage	120 VAC
Encoder Resolution	10000 counts / rev
Speed Torque Curve	

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Description

The BX25A20AC PWM servo drive is designed to drive brushless DC motors at a high switching frequency. It is fully protected against over-voltage, over-current, over-heating and short-circuits. The drive interfaces with digital controllers or can be used as a stand-alone drive and requires only a single AC power supply. A single red/green LED indicates operating status. Loop gain, current limit, input gain and offset can be adjusted using 14-turn potentiometers. The offset adjusting potentiometer can also be used as an on-board input signal for testing purposes when SW1 (DIP switch) is ON. The drive can use quadrature encoder inputs or Hall sensors for velocity control.

Power Range

Peak Current	25 A
Continuous Current	12.5 A
Supply Voltage	45 - 140 VAC

Features

- Four Quadrant Regenerative Operation
- Adjustable Current Limits
- Selectable Inhibit/Enable Logic
- Built in Shunt Regulator Circuit
- On-Board Test Potentiometer
- Offset Adjustment Potentiometer
- Adjustable Input Gain
- Selectable 120/60 Hall Commutation Phasing
- Hall Velocity Mode
- Encoder Velocity Mode
- Selectable Fault Level
- Fault Latching Option
- Built-in brake/shunt regulator
- Internal brake/shunt resistor

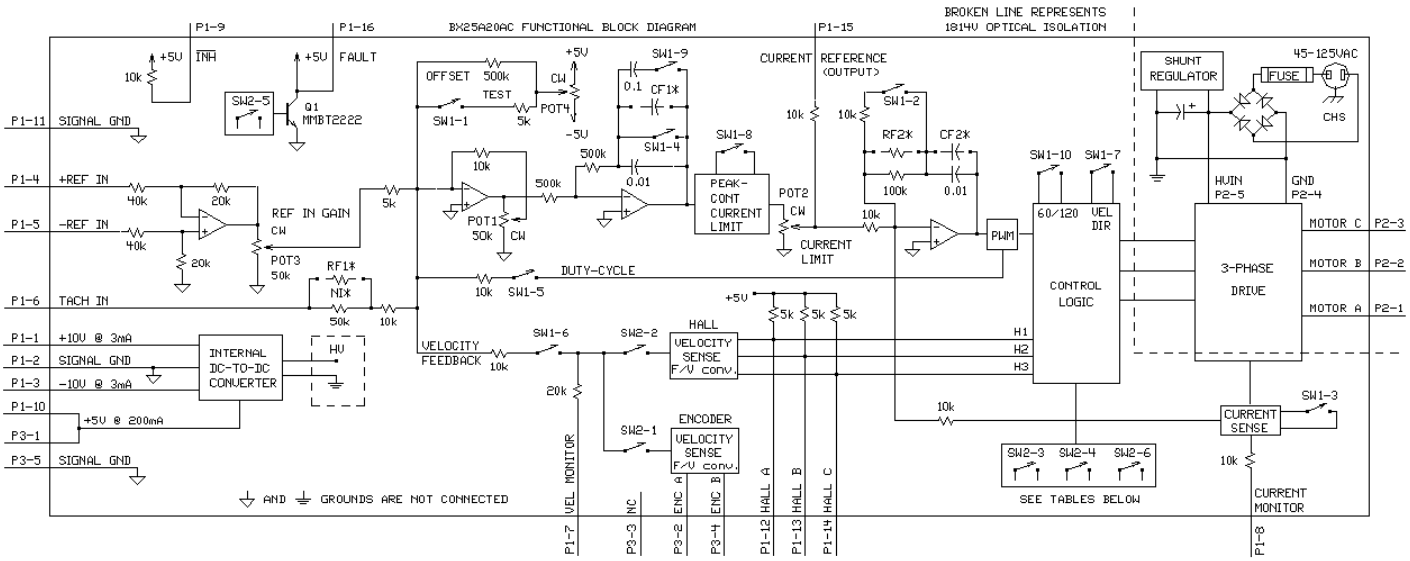
MODES OF OPERATION
- Current
- Duty Cycle (Open Loop)
- Hall Velocity
- Velocity

COMMAND SOURCE
- ±10 V Analog

FEEDBACK SUPPORTED
- Halls
- Incremental Encoder
- Tachometer (±60 VDC)

COMPLIANCES & AGENCY APPROVALS
- UL
- cUL
- CE Class A (LVD)
- CE Class A (EMC)
- RoHS

BLOCK DIAGRAM



MODE SELECTION	SW1-2	SW1-4	SW1-5	SW1-6	SW2-1	SW2-2	ENC	HALL	TACH
CURRENT MODE	ON	ON	OFF	OFF	--	--	NC	CONN	NC
ENCODER VELOCITY	ON	OFF	OFF	ON	ON	OFF	CONN	CONN	NC
HALL VELOCITY	ON	OFF	OFF	ON	OFF	ON	NC	CONN	NC
DUTY CYCLE MODE	ON	OFF	ON	OFF	--	--	NC	CONN	NC
TACHOMETER MODE	ON	OFF	OFF	OFF	--	--	NC	CONN	CONN

NC-NOT CONNECTED CONN-CONNECTED

LED GREEN - NORMAL OPERATION, LED RED- FAULT
RECOMMENDED SETTING FOR CURRENT MODE - POT1 FULLY CCW, POT3 FULLY CW
AMPLIFIERS ARE SHIPPED IN CURRENT MODE WITH MAXIMUM CURRENT SETTINGS
FOR OTHER SWITCH FUNCTIONS SEE SWITCH DESCRIPTION
* OPTIONAL USER INSTALLED THROUGH HOLE COMPONENTS

INHIBIT LEVEL SELECT	
SW2-3	Pull P1-9 to GND to
OFF	ENABLE
ON	INHIBIT

FAULT-INHIBIT RELATION	
SW2-4	INHIBIT=FAULT
OFF	NO
ON	YES

FAULT LEVEL	
SW2-5	OUT (P1-16)
OFF	ACTIVE Lo
ON	ACTIVE Hi

FAULT CONDITION	
SW2-6	LATCH
OFF	YES
ON	NO

FAULT LATCH: 1. OVER VOLTAGE
2. UNDER VOLTAGE
3. SHORT CIRCUIT
4. OVER TEMPERATURE

Information on Approvals and Compliances	
cULus	US and Canadian safety compliance with UL 508c, the industrial standard for power conversion electronics. UL registered under file number E140173. Note that machine components compliant with UL are considered UL registered as opposed to UL listed as would be the case for commercial products.
CE	Compliant with European CE for both the Class A EMC Directive 2004/108/EC on Electromagnetic Compatibility (specifically EN 61000-6-4:2007 and EN 61000-6-2:2005) and LVD requirements of directive 2006/95/EC (specifically EN 60204-1:2006), a low voltage directive to protect users from electrical shock.
RoHS COMPLIANCE	RoHS (Reduction of Hazardous Substances) is intended to prevent hazardous substances such as lead from being manufactured in electrical and electronic equipment.

SPECIFICATIONS

Power Specifications		
Description	Units	Value
AC Supply Voltage Range	VAC	45 - 140
DC Supply Voltage Range	VDC	60 - 200
DC Bus Over Voltage Limit	VDC	205
Maximum Peak Output Current[1]	A	25
Maximum Continuous Output Current	A	12.5
Maximum Continuous Output Power at Continuous Current	W	2375
Internal Bus Capacitance	µF	3600
Internal Shunt Resistance	Ω	10
Internal Shunt Resistor Power Rating	W	50
Internal Shunt Resistor Turn-on Voltage	VDC	185
Minimum Load Inductance (Line-To-Line)[2]	µH	250
Switching Frequency	kHz	22
Shunt Fuse	A	3
Bus Fuse	A	16
Control Specifications		
Description	Units	Value
Command Sources	-	±10 V Analog
Feedback Supported	-	Halls, Incremental Encoder, Tachometer (±60 VDC)
Commutation Methods	-	Trapezoidal
Modes of Operation	-	Current, Hall Velocity, Duty Cycle, Velocity
Motors Supported	-	Single Phase (Brushed, Voice Coil, Inductive Load), Three Phase (Brushless)
Hardware Protection	-	Invalid Commutation Feedback, Over Current, Over Temperature, Over Voltage, Short Circuit (Phase-Phase & Phase-Ground)
Primary I/O Logic Level	-	5V TTL
Internal Shunt Regulator	-	Yes
Internal Shunt Resistor	-	Yes
Mechanical Specifications		
Description	Units	Value
Agency Approvals	-	CE Class A (EMC), CE Class A (LVD), cUL, RoHS, UL
Size (H x W x D)	mm (in)	186.7 x 107.4 x 62.2 (7.4 x 4.2 x 2.4)
Weight	g (oz)	1140 (40.2)
Heatsink (Base) Temperature Range[3]	°C (°F)	0 - 65 (32 - 149)
Storage Temperature Range	°C (°F)	-40 - 85 (-40 - 185)
Form Factor	-	Panel Mount
P1 Connector	-	16-pin, 2.54 mm spaced, friction lock header
P2 Connector	-	3-port, 5.08 mm spaced, screw terminal
P3 Connector	-	5-pin, 2.54 mm spaced, friction lock header

Notes

1. Maximum duration of peak current is ~2 seconds.
2. Lower inductance is acceptable for bus voltages well below maximum. Use external inductance to meet requirements.
3. Additional cooling and/or heatsink may be required to achieve rated performance.

PIN FUNCTIONS

P1 - Signal Connector			
Pin	Name	Description / Notes	I/O
1	+10V 3mA OUT	±10 V @ 3 mA low power supply for customer use. Short circuit protected. Reference ground common with signal ground.	O
2	SIGNAL GND		SGND
3	-10V 3mA OUT		O
4	+REF IN	Differential Reference Input (±10 V Operating Range, ±15 V Maximum Input)	I
5	-REF IN		I
6	-TACH IN	Negative Tachometer Input (Maximum ±60 V). Use signal ground for positive input.	I
7	VEL MONITOR OUT	Velocity Monitor. Analog output proportional to motor speed. In Encoder Velocity mode, output is proportional to the encoder line frequency. In Hall Velocity mode, output is proportional to the electrical cycle frequency. Encoder Velocity scaling is 25 kHz/V. Hall Velocity scaling is 125 Hz/V.	O
8	CURR MONITOR OUT	Current Monitor. Analog output signal proportional to the actual current output. Scaling is 4 A/V by default but may be reduced to half this value by setting DIP switch SW-3 to OFF (see Hardware Settings section below). Measure relative to signal ground.	O
9	$\overline{\text{INHIBIT IN}}$	TTL level (+5 V) inhibit/enable input. Leave open to enable drive. Pull to ground to inhibit drive. Inhibit turns off all power devices.	I
10	+5V	Low Power Supply For Feedback (+5 V @ 200 mA). Referenced to signal ground. Note: the combined current on all +5V outputs on this drive should not exceed 200 mA.	O
11	SIGNAL GND	Signal Ground	SGND
12	HALL 1	Single-ended Hall/Commutation Sensor Inputs (+5 V logic level)	I
13	HALL 2		I
14	HALL 3		I
15	CURR REFERENCE	Measures the command signal to the internal current-loop. This pin has a maximum output of ±7.25 V when the drive outputs maximum peak current. Measure relative to signal ground.	O
16	FAULT OUT	TTL level (+5 V) output becomes high when power devices are disabled due to at least one of the following conditions: inhibit, invalid Hall state, output short circuit, over voltage, over temperature, power-up reset.	O

P2 - Motor Power Connector			
Pin	Name	Description / Notes	I/O
1	MOTOR A	Motor Phase A	O
2	MOTOR B	Motor Phase B	O
3	MOTOR C	Motor Phase C	O

P3 - Feedback Connector			
Pin	Name	Description / Notes	I/O
1	+5V	Low Power Supply For Encoder (+5 V @ 150 mA). Referenced to signal ground. Short circuit protected.	O
2	CHANNEL A	Single-ended encoder channel A input. +5 V logic level.	I
3	NC	Not Connected (Reserved)	-
4	CHANNEL B	Single-ended encoder channel B input. +5 V logic level.	I
5	SIGNAL GND	Signal Ground	GND

HARDWARE SETTINGS

Switch Functions

SW1			
Switch	Description	Setting	
		On	Off
1	Test/Offset. Switches the function of the Test/Offset pot between an on-board command input for testing or a command offset adjustment. OFF by default.	Test	Offset
2	Current loop proportional gain adjustment. ON by default.	Decrease	Increase
3	Current scaling. When OFF, increases sensitivity of current sense thus reducing both peak and continuous current limit by 50%. The scaling of the current monitor output signal becomes ½ its ordinary value when this switch is OFF.	Full-current	Half-current
4	Outer loop integration. Activates or deactivates integration. ON, by default, for current mode and OFF for other modes.	Inactive	Active
5	Mode selection. See mode selection table below.	-	-
6	Mode selection. See mode selection table below.	-	-
7	Velocity feedback polarity. Changes the polarity of the internal feedback signal and the velocity monitor output signal. Inversion of the feedback polarity may be required to prevent a motor run-away condition.	Standard	Inverted
8	Current ratio. Used to set continuous-to-peak current ratio. Default is ON.	Cont./Peak Ratio = 50%	Cont./Peak Ratio = 25%
9	Outer loop integral gain adjustment. It is recommended to leave this switch OFF for most applications, but ON for Hall Velocity Mode.	Decrease	Increase
10	Hall sensor phasing. Selects 120°/60° commutation phasing. ON by default.	120°	60°

SW2			
Switch	Description	Setting	
		On	Off
1	Mode selection. See mode selection table below.	-	-
2	Mode selection. See mode selection table below.	-	-
3	Inhibit logic. Sets the logic level of inhibit pins.	Active Low	Active High
4	Sets whether or not the inhibit input activates the fault output.	Inhibit In ≠ Fault Out	Inhibit In = Fault Out
5	Fault logic. Sets the logic level of fault output.	Active High	Active Low
6	Sets whether or not the fault output should latch. When non-latching, the fault output clears as soon as all fault conditions are released. When latching, the fault output clears only once all fault conditions have been released and the drive is either power cycled or the inhibit input is toggled.	Non-latching Faults	Latching Faults

Mode Selection Table

	SW1-4	SW1-5	SW1-6	SW2-1	SW2-2	Encoder	Tachometer
CURRENT	ON	OFF	OFF	-	-	Not Connected	Not Connected
DUTY CYCLE	OFF	ON	OFF	-	-	Not Connected	Not Connected
HALL VELOCITY*	OFF	OFF	ON	OFF	ON	Not Connected	Not Connected
ENCODER VELOCITY*	OFF	OFF	ON	ON	OFF	Connected	Not Connected
TACHOMETER	OFF	OFF	OFF	-	-	Not Connected	Connected

*NOTE: See details of switch SW1-7 for further Hall Velocity or Encoder Velocity configuration information.

Potentiometer Functions

Potentiometer	Description	Turning CW
1	Loop gain adjustment for duty cycle / velocity modes. Turn this pot fully CCW in current mode.	Increases gain
2	Current limit. It adjusts both continuous and peak current limit while maintaining their ratio.	Increases limit
3	Reference gain. Adjusts the ratio between input signal and output variables (voltage, current, or velocity).	Increases gain
4	Offset / Test. Used to adjust any imbalance in the input signal or in the amplifier. Can also be used as an on-board signal source for testing purposes.	Adjusts offset in negative direction
Note: Potentiometers are approximately linear and have 12 active turns with 1 inactive turn on each end.		

Through-hole Components†

Location	Description
CF1*	Velocity Loop Integrator. Through-hole capacitor that can be added for more precise velocity loop tuning. See section below on Tuning with Through-hole components for more details.
CF2*	Current Loop Integrator. Through-hole capacitor that can be added for more precise current loop tuning. See section below on Tuning with Through-hole components for more details.
RF1*	Tachometer Input Scaling. Through-hole resistor that can be added to change the gain of the tachometer input. See section below on Tachometer Gain for more details.
RF2*	Current Loop Proportional Gain. Through-hole resistor that can be added for more precise current loop tuning. See section below on Tuning with Through-hole components for more details.

Tachometer Gain

Some applications may require an increase in the gain of the tachometer input signal. This occurrence will be most common in designs where the tachometer input has a low voltage to RPM scaling ratio. The drive offers a through-hole location listed in the above table where a resistor can be added to increase the tachometer gain. Use the drive's block diagram to determine an appropriate resistor value.

Tuning With Through-hole Components

In general, the drive will not need to be further tuned with through-hole components. However, for applications requiring more precise tuning than what is offered by the potentiometers and dipswitches, the drive can be manually modified with through-hole resistors and capacitors as denoted in the above table. By default, the through-hole locations are not populated when the drive is shipped. Before attempting to add through-hole components to the board, consult the section on loop tuning in the installation notes on the manufacturer's website. Some general rules of thumb to follow when adding through-hole components are:

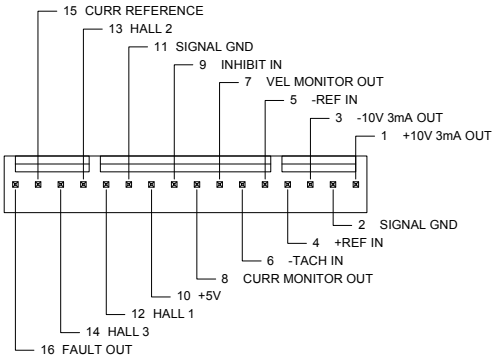
- A larger resistor value will increase the proportional gain, and therefore create a faster response time.
- A larger capacitor value will increase the integration time, and therefore create a slower response time.

Proper tuning using the through-hole components will require careful observation of the loop response on a digital oscilloscope to find the optimal through-hole component values for the specific application.

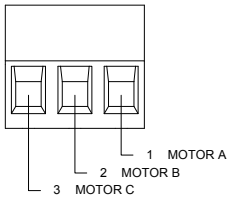
†**Note: Damage done to the drive while performing these modifications will void the warranty.**

MECHANICAL INFORMATION

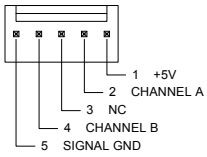
P1 - Signal Connector		
Connector Information		16-pin, 2.54 mm spaced, friction lock header
Mating Connector	Details	Molex: P/N 22-01-3167 (connector) and P/N 08-50-0114 (insert terminals)
	Included with Drive	Yes



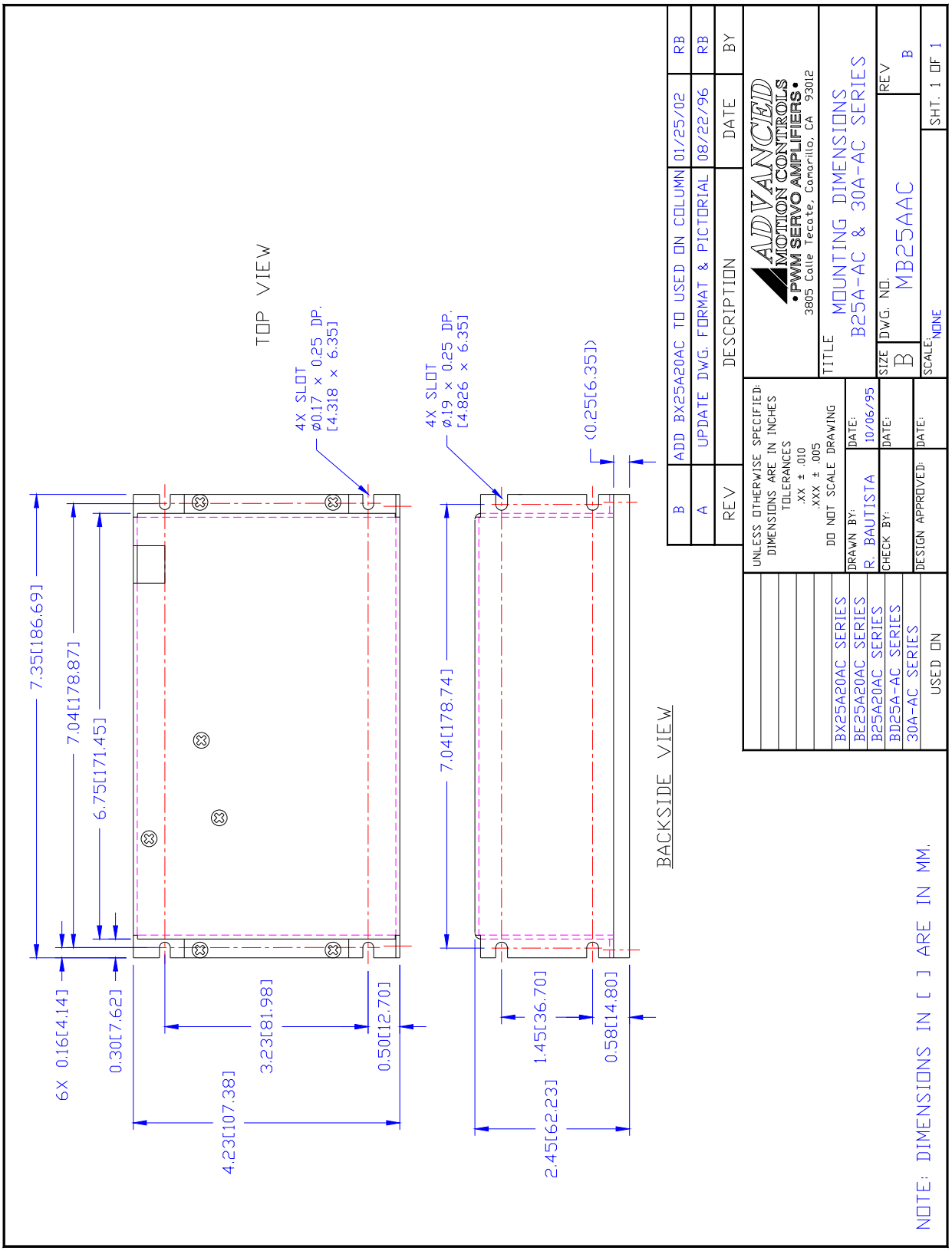
P2 - Motor Power Connector		
Connector Information		3-port, 5.08 mm spaced, screw terminal
Mating Connector	Details	Not applicable
	Included with Drive	Not applicable



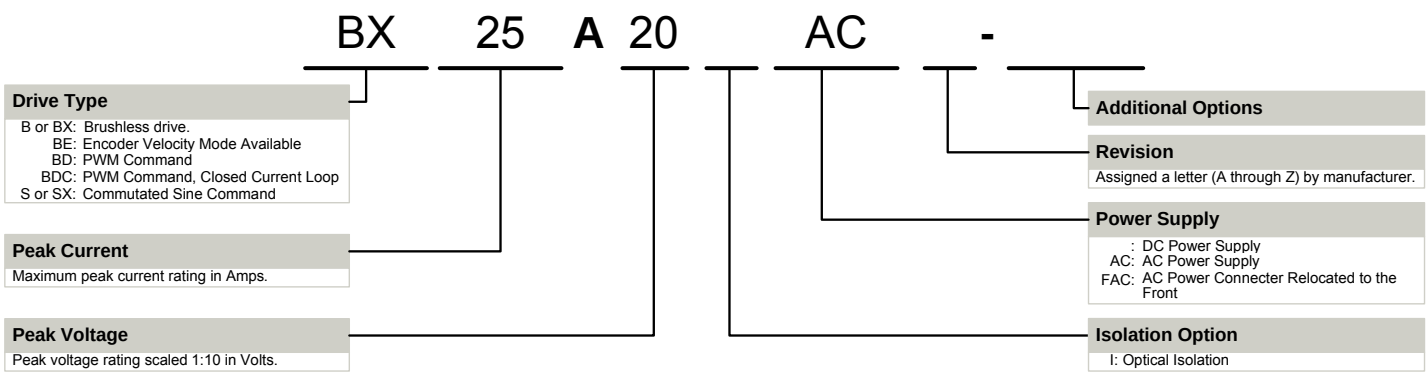
P3 - Feedback Connector		
Connector Information		5-pin, 2.54 mm spaced, friction lock header
Mating Connector	Details	Molex: P/N 22-01-3167 (connector) and P/N 08-50-0114 (insert terminals)
	Included with Drive	Yes



MOUNTING DIMENSIONS



PART NUMBERING INFORMATION


BX 25 A 20 AC -
Drive Type
B or BX: Brushless drive.
BE: Encoder Velocity Mode Available
BD: PWM Command
BDC: PWM Command, Closed Current Loop
S or SX: Commutated Sine Command
Peak Current
Maximum peak current rating in Amps.
Peak Voltage
Peak voltage rating scaled 1:10 in Volts.
Additional Options
Revision
Assigned a letter (A through Z) by manufacturer.
Power Supply
: DC Power Supply
AC: AC Power Supply
FAC: AC Power Connecter Relocated to the Front
Isolation Option
I: Optical Isolation

ADVANCED Motion Controls analog series of servo drives are available in many configurations. All models listed in the selection tables of the website are readily available, standard product offerings.

ADVANCED Motion Controls also has the capability to promptly develop and deliver specified products for OEMs with volume requests. Our Applications and Engineering Departments will work closely with your design team through all stages of development in order to provide the best servo drive solution for your system. Equipped with on-site manufacturing for quick-turn customs capabilities, *ADVANCED* Motion Controls utilizes our years of engineering and manufacturing expertise to decrease your costs and time-to-market while increasing system quality and reliability.

Examples of Customized Products

- Integration of Drive into Motor Housing
- Mount OEM PCB onto Drive Without Cables
- Multi-axis Configuration for Compact System
- Custom PCB and Baseplate for Optimized Footprint
- RTV/Epoxy Components for High Vibration
- OEM Specified Connectors for Instant Compatibility
- OEM Specified Silkscreen for Custom Appearance
- Increased Thermal Limits for High Temp. Operation
- Integrate OEM Circuitry onto Drive PCB
- Custom Control Loop Tuned to Motor Characteristics
- Custom I/O Interface for System Compatibility
- Preset Switches and Pots to Reduce User Setup
- Optimized Switching Frequency
- Ramped Velocity Command for Smooth Acceleration
- Remove Unused Features to Reduce OEM Cost
- Application Specific Current and Voltage Limits

Feel free to contact Applications Engineering for further information and details.

Available Accessories

ADVANCED Motion Controls offers a variety of accessories designed to facilitate drive integration into a servo system. Visit www.a-m-c.com to see which accessories will assist with your application design and implementation.

Drive(s)

Filter Cards

To Motor

All specifications in this document are subject to change without written notice. Actual product may differ from pictures provided in this document.

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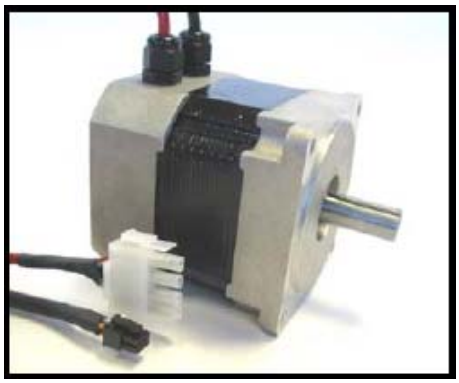
MBL3416E2 BRUSHLESS SERVO MOTOR

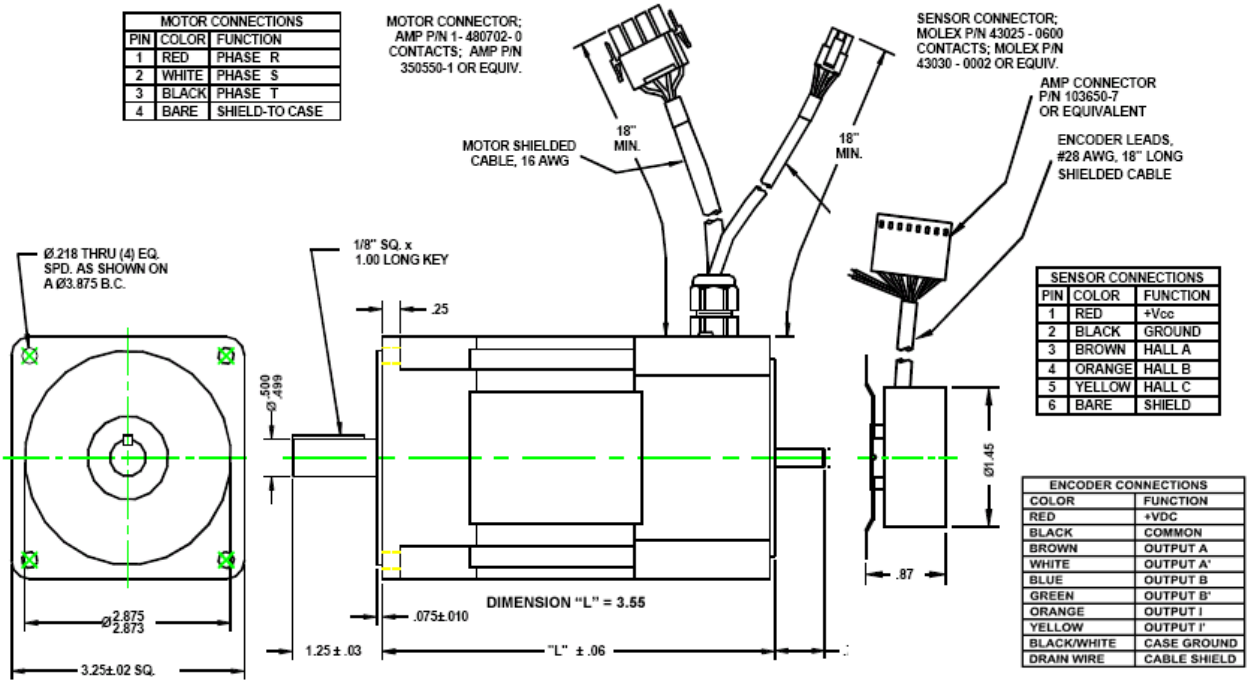


FEATURES:

- 3.25 Inch NEMA 34 w/ Heavy Duty Shaft
- Continuous Torques up to 15.63 lb-in
- Speeds up to 4500 rpm
- Voltage Rating up to 170 Vdc
- Integrated Hall Effect Commutation
- 30 Lb Radial Load Capacity, 1/2" from Front Face
- High Precision Optical Encoders – 10000 count

SPECIFICATIONS:

SPECIFICATIONS	UNITS	VALUE
CONTINUOUS TORQUE	Nm (lb-in)	1.77 (15.63)
PEAK TORQUE	Nm (lb-in)	5.3 (46.9)
SPEED @ RATED VOLTAGE	RPM	4500
RATED VOLTAGE	V dc	170
CONTINUOUS CURRENT	A	12.1
PEAK CURRENT	A	36.3
TORQUE CONSTANT	Nm / A (lb-in / A)	0.159 (1.40)
VOLTAGE CONSTANT	V / KRPM	16.6
RESISTANCE	ohms	0.224
INDUCTNACE	mH	1.08
INERTIA	kg-cm² (lb-in-s²)	2.034 (0.0018)
WEIGHT	Kg (lb)	3.54 (7.8)



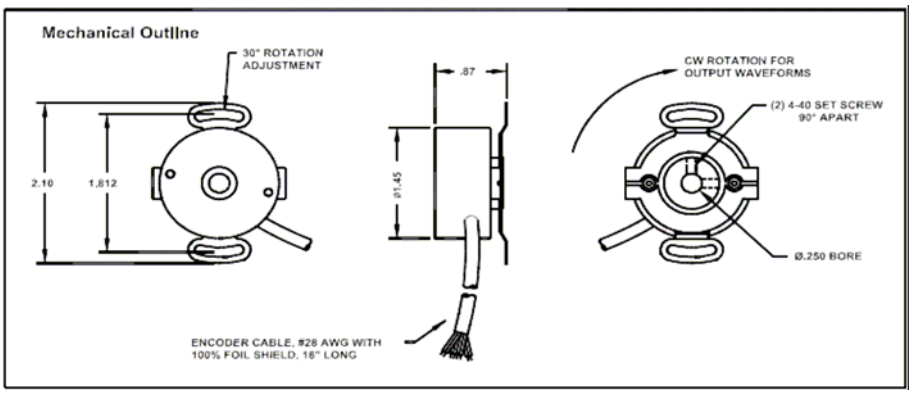
ADVANCED MOTION CONTROLS
3805 Calle Tecate, Camarillo, CA 93012 Tel: (805) 389-1935, Fax: (805) 389-1165

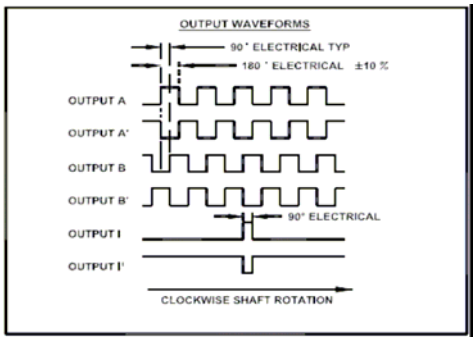
ENCODER:

ELECTRICAL SPECIFICATIONS	VALUE
INPUT VOLTAGE	5 VDC +/- 5%
INPUT CURRENT REQUIREMENTS	125 mA Typical @ 5 VDC Plus Interface Loads
INPUT RIPPLE	2% Peak to Peak @ 5 VDC
OUTPUT CIRCUITS	AM26LS31 RS 422A Line Driver
FREQUENCY RESPONSE	500 kHz
INCREMENTAL OUTPUT FORMAT	Quadrature with A leading B for CW rotation. Index Pulse centered over A.
SYMMETRY	180 Degrees +/- 10% Typical
MINIMUM EDGE SEPARATION	54 electrical degrees
COMMUTATION FORMAT	N/A
COMMUTATION ACCURACY	N/A

ENVIRONMENTAL SPECIFICATIONS	VALUE
STORAGE TEMPERATURE	-40 to 125° C
OPERATING TEMPERATURE	-20 to 100° C Typical
HUMIDITY	98% Non-Condensing
VIBRATION	20 G's @ 50 to 500 CPS
SHOCK	50 G's @ 11 ms duration

MECHANICAL SPECIFICATIONS	VALUE
LINE COUNT	2500 lines/revolution
MAXIMUM SHAFT SPEED	8000 RPM
THROUGH SHAFT DIAMETER	0.250" (-0.0000", +0.0005")
RADIAL SHAFT MOVEMENT	0.007" TIR
AXIAL SHAFT MOVEMENT	+/- 0.030" MAX
HOUSING	Carbon Fiber Composite (case ground via cable)
TERMINATION	15 conductor cable, 28 AWG, 18" long
MOUNTING	1.812" Bolt Circle
MOMENT OF INERTIAL	1.5×10^{-4} oz-in-s^2
ACCELERATION	1×10^{5} Radians/s^2
ACCURACY	+/- 1.0 Arc Minutes





ADVANCED **MOTION CONTROLS**
3805 Calle Tecate, Camarillo, CA 93012 Tel: (805) 389-1935, Fax: (805) 389-1165

CBL-D02 DRIVE CABLE

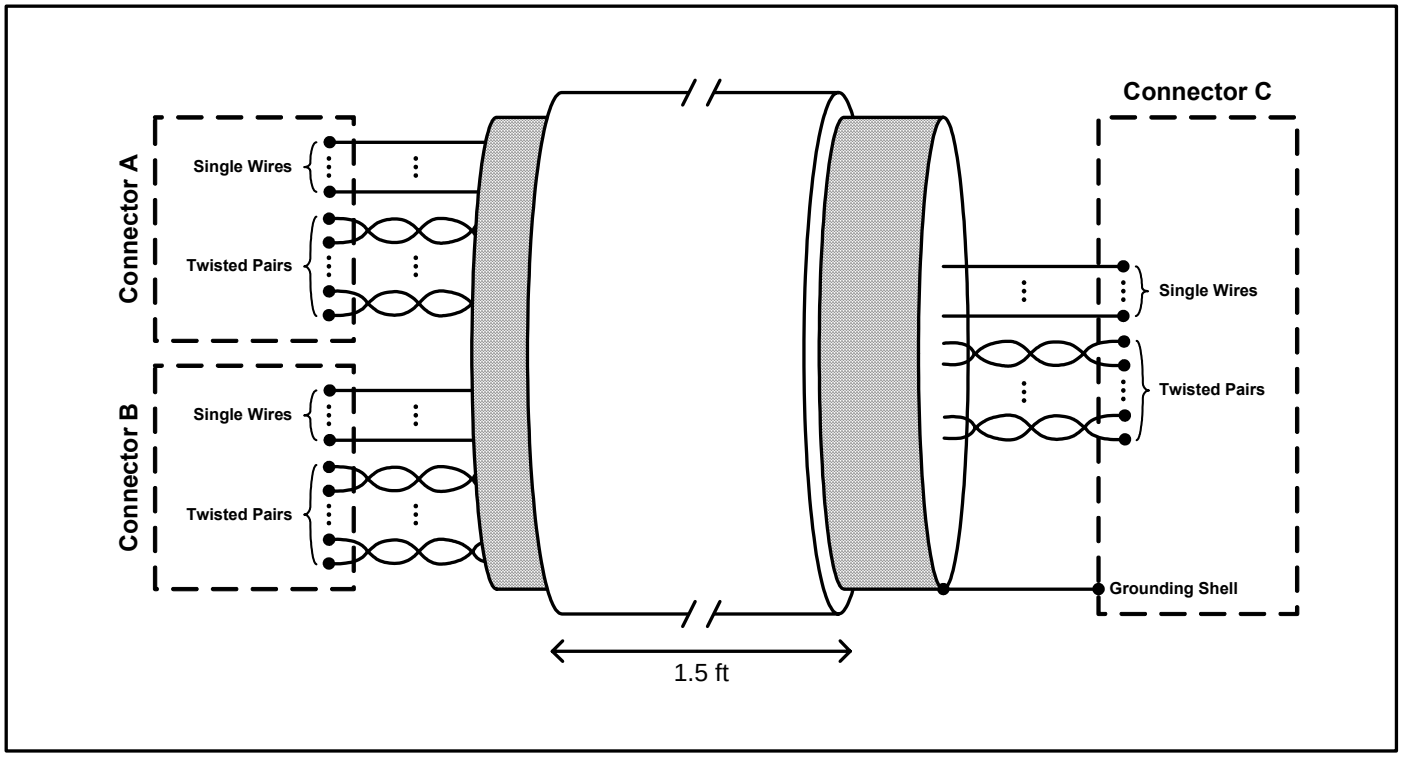
WIRING SPECIFICATIONS:

CABLE: CBL-D02						
Side 1		**Common**			**Side 2**	
Connector	**Contact**	**Wiring Scheme**		**Wire Color**	**Contact**	**Connector**
A **16-Pin Molex** Connector: P/N 22-01-3167 Terminals: P/N 08-50-0114	1	Single Wire	+REF OUT	yellow	1	**C** **26-Pin AMP (D-SUB)** Plug: P/N 748365-1 Housing: P/N 748677-2 Terminals: P/N 748333-4
	2	Single Wire	SGND	yellow/black	2	
	3	Single Wire	-REF OUT	blue	3	
	6	Single Wire	-TACH IN	blue/white	6	
	7	Single Wire	Velocity Monitor	black	7	
	8	Single Wire	Current Monitor	black/white	8	
	9	Single Wire	Inhibit	orange	9	
	12	Single Wire	Hall A	orange/white	12	
	13	Single Wire	Hall B	red	13	
	14	Single Wire	Hall C	red/white	14	
	15	Single Wire	Current Ref.	brown	15	
	16	Single Wire	Fault	brown/white	16	
	4	Twisted Pair	+REF IN	green	4	
	5		-REF IN	green/white	5	
	10	Twisted Pair	5V	purple	10	
	11		SGND	purple/white	11	
B **5-Pin Molex** Connector: P/N 22-01-3057	2	Single Wire*	Encoder A	pink/red	21	
	4	Single Wire*	Encoder B	green/black	23	
	1	Twisted Pair	5V	gray/black	20	
	5		SGND	gray	19	
-	-	Shield	Shield	-	Shell	

NOTE: For cables with only twisted pairs, single wires can be paired with other single or unused wires.

* Do NOT pair these two wires. If pairing is required, pair these wires with unused wires.

DIAGRAM:



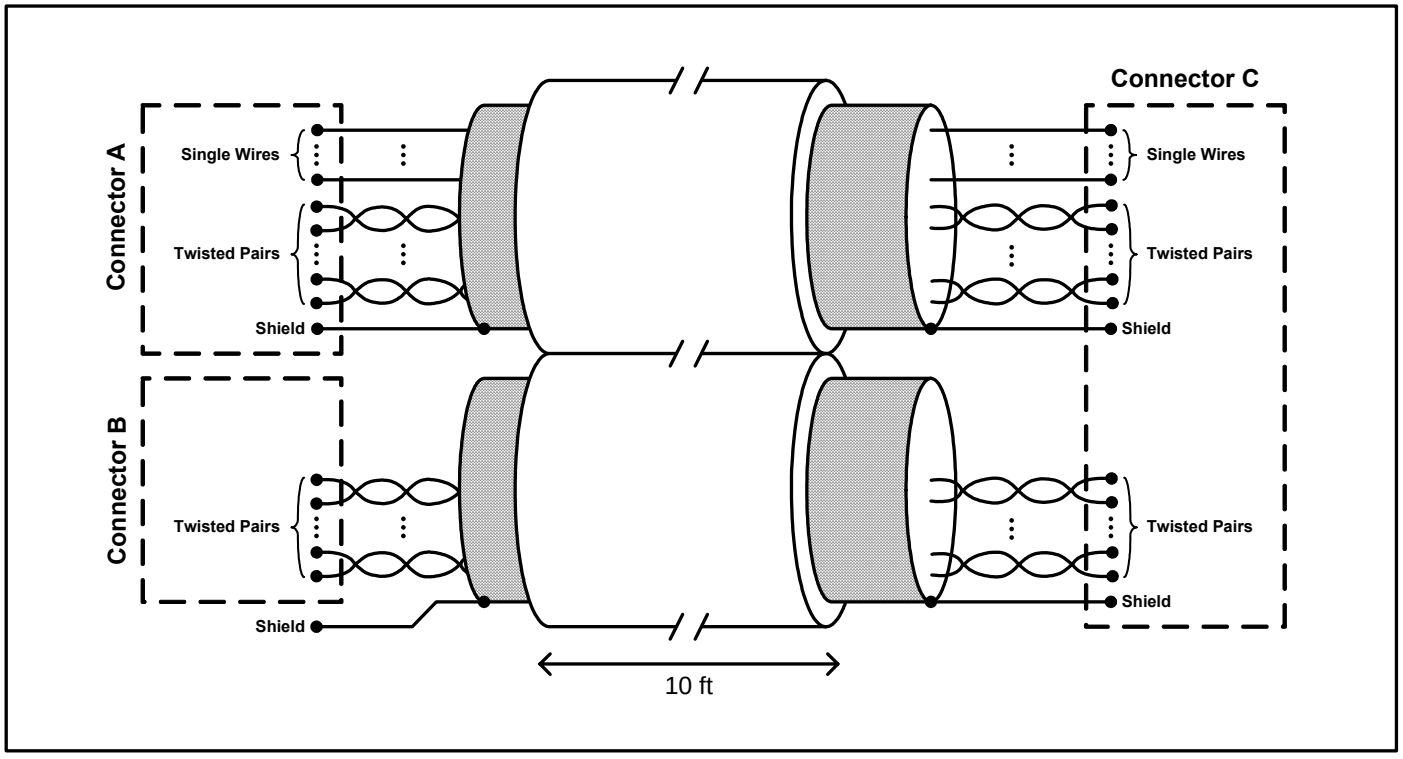
ADVANCED MOTION CONTROLS
3805 Calle Tecate, Camarillo, CA 93012 Tel: (805) 389-1935, Fax: (805) 389-1165

CBL-F01-10 FEEDBACK CABLE

WIRING SPECIFICATIONS:

CABLE: CBL-F01-10						
Side 1		**Common**			**Side 2**	
Connector	**Contact**	**Wiring Scheme**	**Function**	**Wire Color**	**Contact**	**Connector**
A **6-Pin Molex** Connector: P/N 43020-0601 Terminals: P/N 43031-0002	3	Single Wire	Hall A	Brown	1	**C** **15-Pin AMP (D-SUB)** Plug: P/N 748364-1 Housing: P/N 748677-1 Terminals: P/N 748333-4
	4	Single Wire	Hall B	Orange	2	
	5	Single Wire	Hall C	Yellow	3	
	1	Twisted Pair	5V	Red	13	
	2		SGND	Black	12	
	6	Shield	Shield	Sheer	12	
B **8-Pin Molex** Connector: P/N 70107-0007 Terminals: P/N 16-02-0077	3	Twisted Pair	A+	Brown	4	
	4		A-	White	5	
	5	Twisted Pair	B+	Blue	6	
	6		B-	Green	7	
	7	Twisted Pair	I+	Orange	8	
	8		I-	Yellow	9	
	1	Twisted Pair	5V	Red	15	
	2		SGND	Black	14	
	Flying Lead	Shield	Shield	-	14	

DIAGRAM:



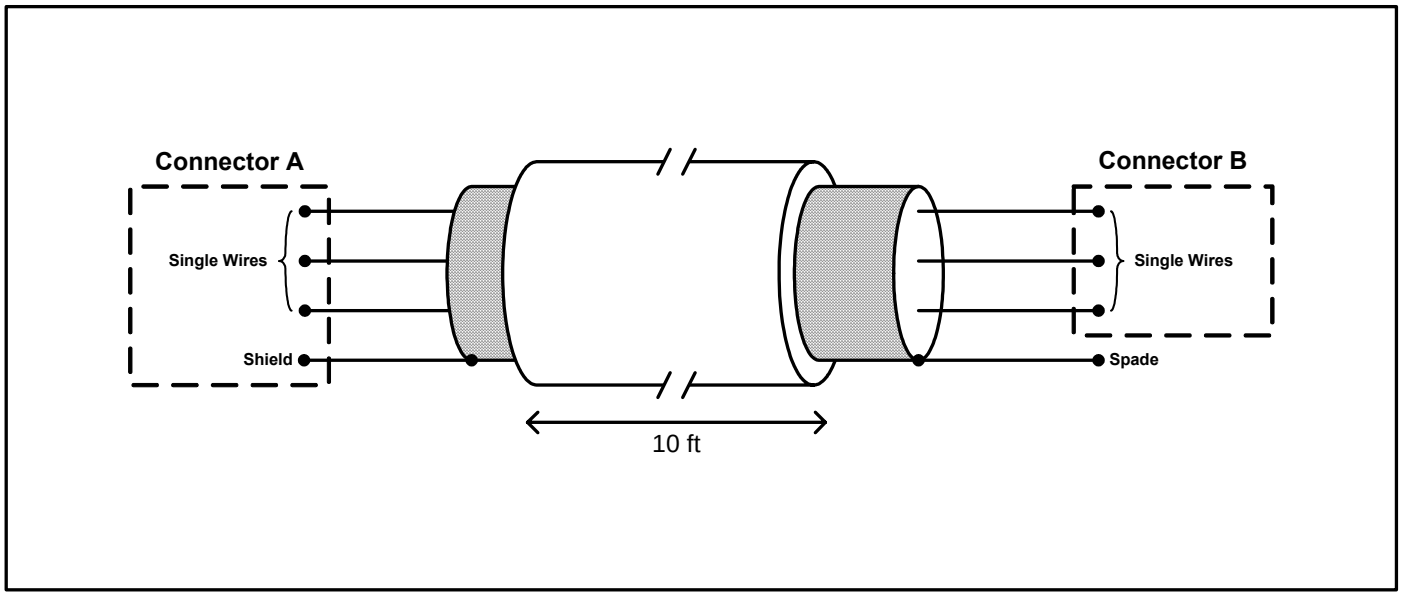
ADVANCED MOTION CONTROLS
3805 Calle Tecate, Camarillo, CA 93012 Tel: (805) 389-1935, Fax: (805) 389-1165

CBL-P02-10 POWER CABLE

WIRING SPECIFICATIONS:

CABLE: CBL-P02-10						
Side 1		Common			Side 2	
Connector	Contact	Wiring Scheme	Function	Wire Color	Contact	Connector
A (4-Pin AMP) Connector, Terminals: P/N 1-480703-0, P/N 350873-1	1	Single Wire	Motor A	red	1	**B (3-Port Phoenix)** Connector: P/N 1757022
	2	Single Wire	Motor B	white	2	
	3	Single Wire	Motor C	black	3	
	4	Shield	Shield	grey	Spade	

DIAGRAM:



ADVANCED MOTION CONTROLS
3805 Calle Tecate, Camarillo, CA 93012 Tel: (805) 389-1935, Fax: (805) 389-1165

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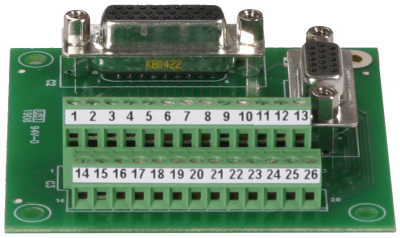
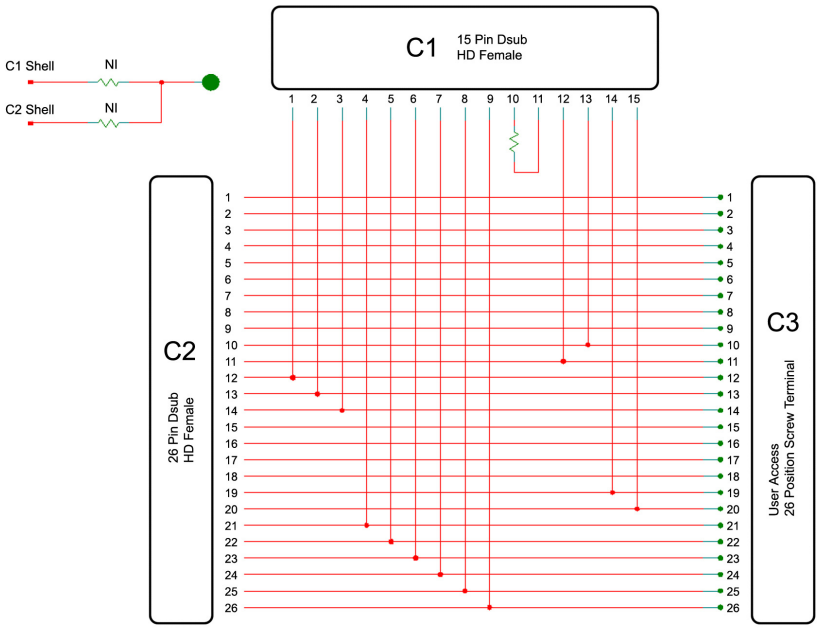
System Interface Board (SIB)



Dimensions	72mm x 72mm
C1 Connector	15 pin to motor
C2 Connector	26 pin to drive
C3 Connector	26 pin user interface

C3 Pin Functions	
Pin	**Function**
1	+10V 3mA
2	SGND
3	-10V 3mA
4	+Ref In
5	-Ref in
6	-Tach In
7	Vel Mon Out
8	Curr Mon Out
9	Inhibit
10	+5V
11	SGND
12	Hall 1
13	Hall 2
14	Hall 3
15	Curr Ref
16	Fault Out
17	--
18	--
19	SGND (Encoder)
20	5V (Encoder)
21	Encoder Channel A+
22	Encoder Channel A-
23	Encoder Channel B+
24	Encoder Channel B-
25	Encoder Channel I+
26	Encoder Channel I-


C1 Shell
NI
C2 Shell
NI
C1
15 Pin Dsub
HD Female
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
C2
26 Pin Dsub
HD Female
C3
User Access
26 Position Screw Terminal
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26